4.5 GEOLOGY AND SOILS

This section describes existing geologic conditions within the SP area and vicinity, identifies associated regulatory requirements and industry standards, evaluates potential impacts, and identifies mitigation measures related to implementation of the proposed project. A Geotechnical Reconnaissance Report and Addendum were prepared for the project by GEOCON, Incorporated (GEOCON, 2010a and 2010b), with this study summarized below and included as Appendix C of this EIR.

4.5.1 Environmental Setting

Geologic Setting

Regional Geology/Topography

The SP area is within the coastal portion of the Peninsular Ranges Geomorphic Province, a region characterized by northwest-trending structural blocks and intervening fault zones. Typical lithologies in the Peninsular Ranges include a variety of igneous, intrusive rocks associated with the Cretaceous-age (between approximately 65 and 135 million years old) southern California Batholith (a large igneous intrusive body). In western San Diego County, batholithic rocks are often intruded into Jurassic-age (between approximately 135 and 195 million years old) metavolcanic and/or metasedimentary units, with these basement rocks locally overlain by Tertiary-age (between approximately 2 and 65 million years old) marine and non-marine sedimentary strata. Tertiary rocks in the western portion of the County are associated primarily with a number of sea level advance and retreat cycles over approximately the last 55 million years, including sedimentary units in the project site and vicinity as described below.

Topographically, the Peninsular Ranges Province is composed of generally parallel ranges of steep-sloping hills and mountains separated by alluvial valleys. More recent uplift and erosion has produced the characteristic canyon and mesa topography present today in western San Diego County, as well as the deposition of surficial materials including Quaternary-age (less than approximately two million years old) alluvium, colluvium and topsoil.

Specific Plan Area Geology/Topography

The SP area is located in an area of former marshland associated with the nearby Buena Vista Creek and Lagoon. Relatively steep slopes ascend generally east from the SP area. Geologic

units mapped within and adjacent to the SP area include the Tertiary-age Santiago Formation and Quaternary-age alluvial deposits. The Santiago Formation is mapped along the southern site boundary and in most surrounding areas, and likely underlies the entire property at depth. Quaternary alluvium and a number of Holocene-age (less than approximately 12,000 years old) native topsoils are mapped as overlying the Santiago Formation in much of the SP area, although the surficial topsoil deposits have been removed/replaced by previous development. Additional description of geologic and surficial units in the SP area and vicinity is provided below under *Stratigraphy*.

Prior to development, the low-lying marshland within and adjacent to the SP area exhibited level terrain, with elevations of approximately 5 to 10 feet AMSL. Development of the Westfield Carlsbad shopping center and surrounding areas involved the placement of compacted fill within the previous marshland areas to create level building pads (as well as subsequent paving and construction), with current on-site elevations of approximately 25 to 40 feet AMSL. A distinct grade break extends generally east-west through the site, with the northern two-thirds of the shopping center property at relatively lower elevations (lower level), and the southern one-third of the site exhibiting relatively higher elevations (upper level).

Stratigraphy

Mapped surficial and geologic exposures within and adjacent to the SP area include recent fill deposits associated with existing development (compacted fill), Holocene-age native topsoils, Quaternary-age alluvium, and the Tertiary-age Santiago Formation as previously noted. These units are described below in order of increasing age, with a regional geologic map encompassing the SP area included as Figure 3 of Appendix C.

Compacted Fill

Compacted fill deposits have been placed over much of the site in association with previous grading and development. These materials range up to approximately 35 feet thick, with more substantial deposits located in the western and northwestern portions of the SP area, and fill mostly absent in the southeastern corner. On-site fills generally encompass a mix of clayey sands, silty sands, silty clays and sandy clays.

Native Topsoils

Mapped topsoils within and adjacent to the SP area generally consist of fine-grained tidal deposits (i.e., materials related to periodic tidal inundation), and loamy sands of the Carlsbad, Las Floras and Marina soil series (U.S. Soil Conservation Service 1973). Based on the described nature and extent of previous on-site development, however, native topsoils are assumed to have been completely removed and/or altered (e.g., by mixing with fill), and are not discussed further in this analysis.

Alluvium

Alluvial materials associated with bay-estuary deposition underlie compacted fill in portions of the SP area, and generally encompass a mix of loose to medium-dense silt, sand and clay. On-site alluvial materials range up to approximately 100 feet in thickness, with more substantial deposits located in the northwestern portion of the SP area and alluvium generally absent to the southeast.

Santiago Formation

The Eocene-age (between approximately 34 and 56 million years old) Santiago Formation is mapped along the southern boundary of the SP area and likely underlies the entire site, with depths generally increasing to the north. This unit consists primarily of relatively flat-lying interbeds of weak/waxy claystone, siltstone, and medium- to coarse-grained sandstone units.

Groundwater

Based on previous geotechnical investigation of the SP area, the project Geotechnical Reconnaissance Report estimates that shallow groundwater occurs on-site at depths of approximately 13 to 15 feet, and may be influenced by seasonal variation and the presence of water in the adjacent Buena Vista Creek channel (refer to Section 4.8, *Hydrology and Water Quality*, for additional discussion of regional and local groundwater conditions).

Structure/Seismicity

The SP area, along with most of southern California, is within a broad, seismically active region characterized by a series of northwest-trending faults associated with the San Andreas Fault System. No active or potentially active faults are mapped or known to occur within or adjacent

to the site, with the closest such structures associated with offshore portions of the Newport-Inglewood/Rose Canyon Fault Zone, approximately 5.8 to 6.2 miles to the west (Figure 4.5-1, *Regional Fault Map*). Active faults are defined as those exhibiting historic seismicity or displacement of Holocene materials, while potentially active faults have no historic seismicity and displace Pleistocene-age (between approximately 12,000 and 2 million years old) but not Holocene strata.

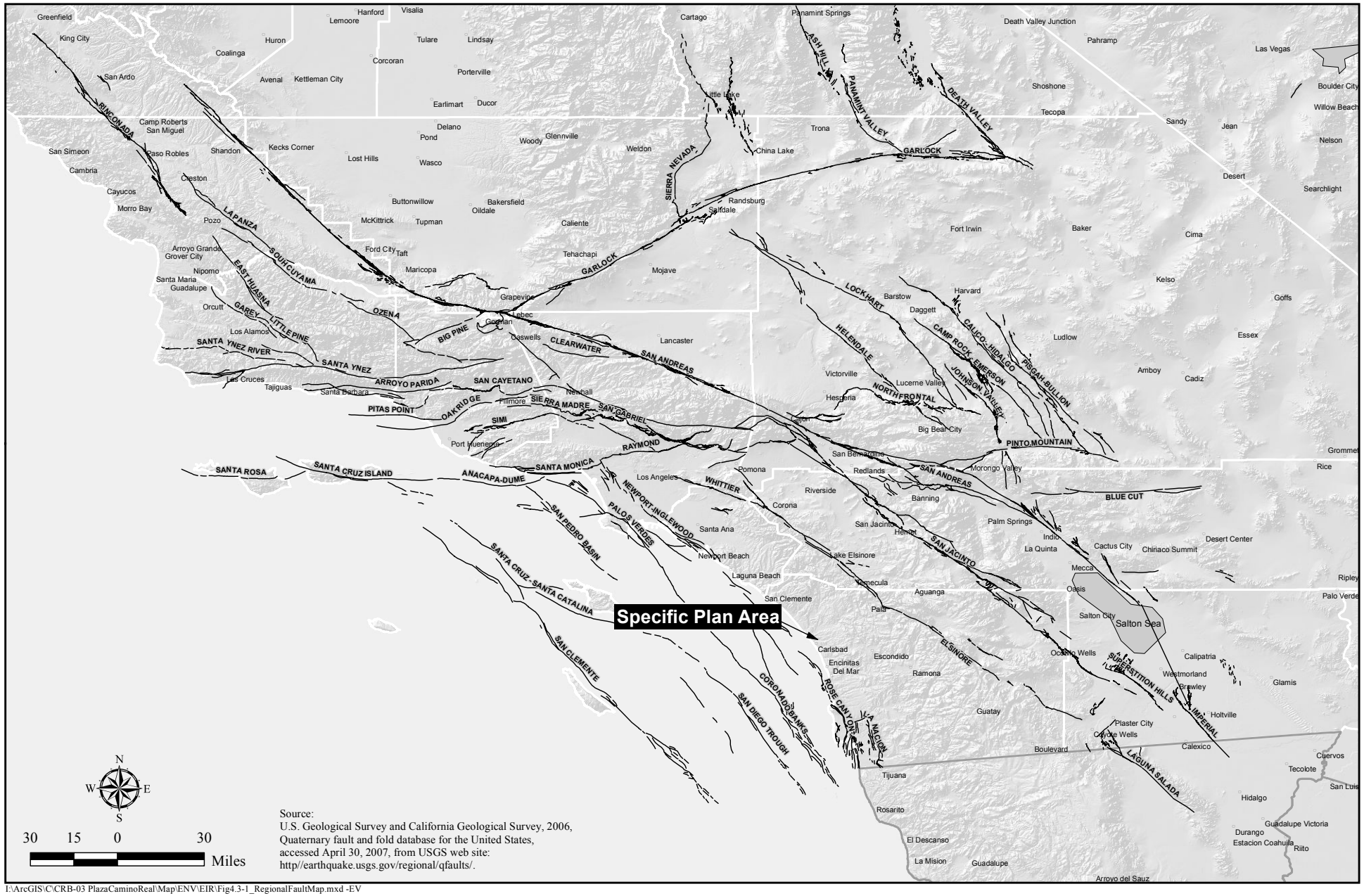
No Earthquake Fault Zones or other seismic hazard designations identified by the California Geological Survey (CGS, formerly the California Division of Mines and Geology [CDMG]) or City of Carlsbad are present within the SP area and vicinity (CGS 2007, City of Carlsbad 1994b). The closest seismic hazard designations are CGS Earthquake Fault Zones located along the Elsinore Fault Zone, approximately 23 miles northeast of the SP area. The described CGS Earthquake Fault Zones designations are generally intended to "[r]egulate development near active faults so as to mitigate the hazard of surface fault rupture" (CGS 2007).

A number of additional major active faults are located within approximately 35 miles of the SP area, with associated seismicity and peak ground acceleration (or ground shaking) values identified in the Geotechnical Reconnaissance Report (Appendix C). Based on this analysis, the maximum on-site peak horizontal ground acceleration level is estimated at 0.34g, in association with a magnitude 7.1 or 7.2 earthquake along proximal (offshore) segments of the Newport-Inglewood and Rose Canyon faults, respectively (where "g" equals the acceleration due to gravity). A summary of location and seismicity data for the faults considered most likely to affect the SP area is provided in Table 4.5-1, *Regional Fault Locations and Seismicity Data*.

Table 4.5-1
REGIONAL FAULT LOCATIONS AND SEISMICITY DATA

Fault Name	Distance/Direction From Site (Miles)	Estimated Maximum Magnitude	Peak Site Acceleration (g)
Newport-Inglewood	5.8/W	7.1	0.34
Rose Canyon	6.2/W	7.2	0.34
Coronado Bank	22.4/WSW	7.6	0.17
Elsinore-Temecula	22.7/NE	6.8	0.11
Elsinore-Julian	23.1/ESE	7.1	0.12
Elsinore-Glen Ivy	32.1/N	6.8	0.07
San Joaquin Hills	34.5/NNW	6.6	0.07
Palos Verdes	35.8/NNW	7.3	0.09

Source: GEOCON 2010; CDMG 1994



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Regional Fault Map

WESTFIELD CARLSBAD

HELIX Environmental Planning

Figure 4.5-1

Regulatory Setting

The proposed Westfield Carlsbad SP and SDP are subject to a number of regulatory requirements and/or guidelines related to potential geologic and soil issues. These standards typically involve measures to evaluate risk and address potential hazards through design and construction techniques. Specific requirements and/or guidelines that are applicable to the project include: (1) the California Seismic Hazards Mapping Act; (2) the Alquist-Priolo Earthquake Fault Zoning Act; (3) the International Building Code (IBC; International Code Council [ICC] 2006); (4) the related California Building Code (CBC; California Code of Regulations [CCR], Title 24, Part 2); and (5) City standards including the General Plan Public Safety Element (1994b), applicable elements of the City Code of Ordinances (including Titles 15 [Grading and Drainage] and 18 [Building Codes and Regulations]), and the *Technical Guidelines for Geotechnical Reports* (1993). The listed regulatory requirements and industry standards are summarized below and discussed as applicable under the evaluation of potential project impacts in Section 4.5.3. Discussion of erosion control (and other) requirements under the National Pollutant Discharge Elimination System (NPDES) and related City standards is provided in Section 4.8 of this EIR, due to the relationship between these issues and water quality concerns.

California Seismic Hazards Mapping Act

The California Seismic Hazards Mapping Act (Public Resources Code; Division 2, Chapter 7.8, §2690 et seq.) provides a statewide seismic hazard mapping and technical advisory program to assist local governments in protecting public health and safety relative to seismic hazards. The act provides direction and funding for the State Geologist to compile seismic hazard maps and to make those maps available to local governments. The Seismic Hazards Mapping Act, along with related standards in the Seismic Hazards Mapping Regulations (CCR; Title 14, Division 2, Chapter 8, Article 10, Section 3270 et seq.), also directs local governments to require the completion and review of appropriate geotechnical studies prior to approving development projects. These requirements are implemented on a local level through means such as general plan directives and regulatory ordinances, including the referenced City standards.

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Act (Public Resources Code Section 2621 et seq.) is intended to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The law requires the State Geologist to establish regulatory zones known as Earthquake Fault Zones (previously called Special Studies Zones and Fault-Rupture Hazard Zones) around the surface

traces of active faults, and to distribute maps of these zones to all affected cities, counties and State agencies. The Alquist-Priolo Act also requires completion of a geologic investigation prior to project approval, to demonstrate that applicable structures would not be constructed across active faults, and/or that appropriate setbacks from such faults (generally 50 feet) are included in the project design.

International Building Code Standards

The IBC provides standard specifications for engineering and construction activities, including measures related to geologic issues. The IBC guidelines are produced by the ICC and, while not comprising formal regulatory requirements, are widely accepted by regulatory authorities and are routinely included in related standards such as local grading codes. The guidelines are regularly updated to reflect current industry standards and practices, including criteria such as ASTM International (formerly known as the American Society for Testing and Materials). ASTM International produces industry standards for a wide variety of materials and procedures, including geologic criteria such as soil borings and sampling; fill composition, compaction and moisture content; expansive soils; and laboratory analyses.

California Building Code Standards

The CBC encompasses a number of requirements related to geologic issues, including seismic safety (Chapter 23); foundation and retaining wall design (Chapter 29); site demolition and excavation (Chapter 33); and grading, drainage and erosion control (Chapter 70). The CBC is based on the previously described IBC, with appropriate amendments and modifications to reflect site-specific conditions in California.

City of Carlsbad Standards

General Plan Public Safety Element

The Public Safety Element is generally intended to avoid or minimize health and safety issues related to geologic and seismic hazards from proposed development. A number of associated goals/objectives and policies are identified, including the following: (1) establish programs for geotechnical review, hazard identification, maintenance of up-to-date technical databases and public awareness; and (2) require appropriate geotechnical investigations, regulatory oversight, hazard/issue remediation and conformance with applicable legal requirements.

Code of Ordinances Title 15 – Grading and Drainage

Title 15, the Grading Ordinance, establishes minimum requirements for grading associated with development under Titles 20 (Subdivisions) and 21 (Zoning). The Grading Ordinance is intended to facilitate appropriate planning, design and construction of development within the City, while ensuring compatibility with associated physical conditions, environmental resources and legal/regulatory requirements.

Code of Ordinances Title 18 – Building Code

The City Building Code is intended to regulate the construction of applicable facilities, and encompasses (and formally adopts) associated elements of the IBC/CBC. Specifically, this includes guidelines related to regulating the "[e]rection, construction, enlargement, alteration, repair, moving, removal, demolition, conversion, occupancy, equipment, use, height, area, and maintenance of all buildings or structures in the City of Carlsbad…"

Technical Guidelines for Geotechnical Reports

The City geotechnical report guidelines identify specific requirements for various levels of geotechnical evaluation, including Reconnaissance Studies, Preliminary Geotechnical Investigation Reports, and As-Graded Geotechnical Reports. Guidelines for all of the noted reports include requirements such as literature review; field investigation/mapping; descriptions of geologic, seismic and engineering conditions; and conclusions/recommendations to identify potential issues and related mitigation requirements, and to ensure conformance with applicable regulations and standards.

4.5.2 Thresholds for Determining Significance

Appendix G of the State CEQA Guidelines provides direction for determining the significance of potential project-related impacts associated with geology and soils issues. (The Appendix G question pertaining to projects where sewer service is not available is not discussed below, as it is not applicable to the proposed project.) Based on these guidelines and other applicable criteria, a significant impact would occur if the proposed project would:

- Expose people or structures to potentially substantial adverse effects, including the risk of loss, injury or death involving: (1) rupture of a known earthquake fault as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map; (2) strong seismic ground

shaking; (3) seismic-related ground failure, including liquefaction; (4) landslides; or (5) seismically-induced tsunamis or seiches;
- Result in substantial soil erosion or the loss of topsoil;
- Be located on a geologic unit or soil that is unstable, or that may become unstable as a result of the project, and potentially result in on-site or off-site landslides, lateral spreading, subsidence, liquefaction or collapse; or
- Be located on expansive soil, as described in Section 1802.3.2 of the IBC.

4.5.3 Environmental Impact

The project Geotechnical Reconnaissance Report (Appendix C) does not identify any soil or geologic conditions within the SP area that would preclude implementation of the proposed SDP. The report does identify a number of potentially significant geotechnical issues, however, related to seismically-induced ground acceleration (ground shaking) and liquefaction/dynamic settlement, as well as compressible or expansive soils, shallow groundwater/drainage, remedial grading requirements/oversize materials, and foundation/footing/pavement/retaining wall design. These potential geotechnical hazards are described below along with other applicable geotechnical issues. The project Geotechnical Reconnaissance Report also notes that a detailed geotechnical investigation "[w]ill be necessary to evaluate the subsurface conditions at the site and to provide recommendations for design and construction of the proposed improvements." This investigation, along with standard regulatory/industry measures typically employed to address identified concerns, is described below and in Section 4.5.4, as appropriate.

Seismic Hazards

Ground Rupture

No significant impacts related to seismically-induced ground rupture are anticipated in association with implementation of the proposed SDP. This conclusion is based on the fact that no known active or potentially active faults (or Earthquake Fault Zones) are located within or adjacent to the site. While the potential for effects related to seismic ground rupture cannot be totally discounted (unknown faults could potentially occur on site, for example), the probability for seismically-induced ground rupture or related effects within the SP area is considered low.

Ground Acceleration (Ground Shaking)

The estimated peak ground acceleration level identified for the site (0.34g) could potentially result in significant impacts to proposed structures and related facilities (e.g., pavement, footings and utilities), as well as associated public safety. The Geotechnical Reconnaissance Report concludes that the site "[c]ould be subject to moderate to severe ground shaking…", and recommends that seismic ground shaking be evaluated as part of the detailed project geotechnical investigation. Based on the noted seismic conditions and required conformance with applicable regulatory/industry standards such as the IBC, seismic design criteria that would likely be incorporated into the project design include pertinent ground acceleration values, as well as parameters related to the seismic zone, subsurface profile types, seismic and near-source coefficients for acceleration and velocity, and the seismic source. Specific design measures related to seismic ground shaking would be identified as part of the detailed geotechnical investigation outlined in Section 4.5.4, and may include standard industry practices such as the use of properly engineered fill, foundation/footing and structure design, and reinforced concrete and masonry.

Liquefaction/Dynamic Settlement and Lateral Spreading

Liquefaction is the phenomenon whereby soils lose shear strength due to a rapid increase in pore-water pressure and exhibit fluid-like flow behavior. Liquefaction is most commonly associated with seismic activity, and typically occurs in areas with cohesionless soils exhibiting relative densities of less than 70 percent and shallow groundwater. The northern portion of the SP area is within a high-risk liquefaction zone, as mapped by the County of San Diego (Appendix C). A number of alluvial deposits mapped within the site are also identified as exhibiting moderate to high liquefaction potential (Appendix C), with associated potential impacts considered significant. Alluvial materials are recommended for additional investigation as part of the detailed project geotechnical investigation outlined in Section 4.5.4. Specific design measures related to seismically-induced liquefaction would be identified as part of that analysis, and may include standard industry practices such as removal/recompaction of liquefiable materials, replacement of unsuitable soils with engineered fill, use of surface/subsurface drains to avoid or reduce saturation, and/or placement of foundation structures (e.g., piles) below liquefiable materials.

Seismically-induced (dynamic) settlement can result from liquefaction, or can occur as a result of the partial re-arrangement of loose, dry sandy materials located above the groundwater table. Settlement or differential settlement (varying degrees of settlement over relatively short

distances) can affect the integrity of associated facilities such as structures, pavement, and utilities. The potential for dynamic settlement at the project site would be evaluated as part of the detailed geotechnical investigation described in Section 4.5.4, with such impacts considered potentially significant. Specific design measures related to dynamic settlement would be identified as part of that analysis if appropriate, and may include standard industry practices such as removal and replacement of settlement-prone materials with engineered fill, use of deep foundation structures, design of proposed facilities to accommodate estimated settlement, or the use of ground improvement techniques such as vibrocompaction or compaction grouting (Appendix C).

Liquefaction-induced lateral spreading consists of the lateral displacement of gently sloping ground surfaces, and generally occurs in areas with slopes of less than five percent that are underlain by loose sandy materials and shallow groundwater. The project Geotechnical Reconnaissance Report concludes that "The potential for lateral spreading due to liquefaction is considered relatively low and would be confined to the drainage channel and highway embankment." (i.e., along the northern edge of the SP area). While the noted areas are not proposed for improvement as part of the current SDP proposal, potential lateral spreading impacts would be evaluated as part of the assessment of liquefaction to be conducted during the detailed geotechnical investigation described in Section 4.5.4. Potential measures to address potential lateral spreading concerns, if applicable, would be similar to those noted above for liquefaction.

Tsunamis and Seiches

Tsunamis are long wavelength (i.e., long relative to the underlying ocean depth) ocean waves generated by sudden movements of the ocean bottom during events such as submarine earthquakes, volcanic activity, or landslides. The project Geotechnical Reconnaissance Report concludes that the potential for tsunamis to affect the site is low, based on the relative elevation of the SP area compared to sea level, the distance to the Pacific Ocean, and the fact that the site is not within any mapped tsunami hazard areas (Appendix C). Accordingly, no significant impacts related to tsunamis would be associated with project implementation.

Seiches are defined as wave-like oscillatory movements in enclosed or semi-enclosed bodies of water such as lakes or reservoirs. Potential effects from seiches include flooding damage and related hazards (e.g., erosion) in surrounding areas from spilling or sloshing water, as well as increased pressure on containment structures. The SP area is not located adjacent to or in close proximity to any large upstream water bodies, and is not within any mapped seiche hazard areas

(Appendix C). Accordingly, no significant impacts related to seiches would be associated with project implementation.

Non-seismic Hazards

Soil Erosion/Loss of Soils

Implementation of the proposed project would require grading, including excavation that potentially could cause erosion from exposed soil at an accelerated rate during storm events, if not properly controlled. The amount and rate of potential construction-related erosion would vary depending on a number of factors, including the time of year, the amount and intensity of rainfall, and the amount of natural and/or artificial fill. Therefore, implementation of the proposed project could result in significant impacts related to erosion and loss of soils. Recommendations for grading/earthwork and other pertinent geotechnical design considerations will be formulated in the final geotechnical report and will be included in the final grading and building plans for the current SDP.

A Storm Water Pollution Prevention Program (SWPPP) would be prepared for the construction phase of the project, in accordance with the City Grading Ordinance and consistent with City Storm Water Standards. The SWPPP would address BMPs which reduce or eliminate pollutants in storm water discharge, including installation and maintenance of drainage and erosion control measures. Additional discussion of the required SWPPP and other state and City standards related to erosion control and soil loss can be found in Section 4.8, *Hydrology and Water Quality*.

In addition, as described in Section 4.8, the Municipal Storm Water Permit (RWQCB Order No. R9-2007-0001, NPDES No. CAS0108758) addresses controls to reduce pollutants in discharges in the post-construction, operational phase. The permit includes a requirement for co-permittees to prepare a Standard Urban Storm Water Mitigation Plan (SUSMP); the City has prepared a local SUSMP and adopted related standards and ordinances as described in greater detail Section 4.8. The purpose of the SUSMPs is to reduce the negative impacts to receiving waters resulting from urban runoff from development, and includes requirements for developers to implement post-construction BMPs to reduce stormwater flows and the associated pollutant loads generated from their project site.

Although the project would comply with the state and City regulations related to erosion and soil loss both during and after construction, the project would implement construction-related BMPs as described in Section 4.8 and, if applicable, recommendations from the detailed geotechnical investigation report to be prepared.

Landslides/Slope Stability

The project Geotechnical Reconnaissance Report concludes that "No evidence of landsliding was noted during the reconnaissance or previous investigation, and no landslides are known to exist on the property or at a location that would impact the proposed development." Based on this conclusion and the fact that the site is generally level as a result of previous development, no significant impacts related to landslides would occur in association with project implementation.

The project Geotechnical Reconnaissance Report also notes that no major cut or fill slopes are planned as part of the site development, and concludes that "[e]xisting slopes should be grossly and surficially stable with respect to deep-seated instability and shallow sloughing conditions." Accordingly, no significant impacts related to slope stability would be associated with the proposed project. As previously noted, discussion of surficial stability issues related to erosion and sedimentation is provided in Section 4.8 of this EIR, due to the relationship between these issues and water quality concerns.

Compressible/Expansive Soils

The project Geotechnical Reconnaissance Report identifies the potential for compression of on-site alluvial materials under load, and notes that portions of the Santiago Formation "[t]ypically posses a medium to high expansion potential…" Potential impacts associated with compressible and expansive soils as noted are considered significant, and would be evaluated as part of the detailed geotechnical investigation described in Section 4.5.4. Specific related design measures would be identified as part of that analysis if appropriate, and may include standard industry practices such as removal and replacement of unsuitable materials with engineered fill, capping or burial of expansive soils in deeper fills, and surcharging/monitoring of compressible deposits prior to development.

Shallow Groundwater/Drainage

Shallow groundwater is anticipated to occur in the SP area at approximate depths of 13 to 15 feet. While the occurrence of shallow groundwater would not constitute a significant geotechnical impact, per se, it could require temporary dewatering to allow access by construction equipment and/or personnel. Associated dewatering activities would require conformance with applicable NPDES permit requirements, as discussed in Section 4.8 of this EIR. The presence of shallow groundwater could also potentially affect the stability of proposed excavations (e.g., trench walls), resulting in potentially significant safety impacts to construction

workers and equipment from caving. Potential impacts associated with shallow groundwater would be evaluated as part of the detailed geotechnical investigation described in Section 4.5.4. Specific related design measures would be identified as part of that analysis if appropriate, and would likely include conformance with applicable Occupational Safety and Health Administration (OSHA) and California Division of OSHA (CAL/OSHA) standards (e.g., 29 Code of Federal Regulations [CFR] Part 1926, Occupational Health Standards-Excavations). Specifically, this could include the use of appropriate shoring to stabilize temporary excavations.

Uncontrolled or improperly designed surface or subsurface drainage can result in adverse impacts to proposed development through effects such as ponding, saturation of surficial deposits, or erosion. The project Geotechnical Reconnaissance Report also notes that "The Santiago Formation typically has a high to moderate potential to transmit seepage along impervious layers within the formation." Based on these conditions, potential impacts associated with surface and subsurface drainage at the project site are considered potentially significant. These potential impacts would be evaluated as part of the detailed geotechnical investigation described in Section 4.5.4. Specific design measures would be identified as part of that analysis if appropriate, and may include standard industry techniques such as the use of positive drainage (i.e., grading/construction to direct surface flows away from structures and into designated drainage facilities), and/or subdrains to avoid subsurface saturation in applicable areas.

Remedial Grading

The project Geotechnical Reconnaissance Report identifies the potential need to develop remedial grading requirements in association with potentially significant impacts from conditions such as liquefiable or expansive soils. The report notes that such potential requirements would be evaluated as part of the detailed geotechnical investigation described in Section 4.5.4, with typical remedial measures including the removal and replacement of unsuitable materials with engineered fill (as described above for applicable issues).

The Geotechnical Reconnaissance Report also notes that the Santiago Formation often exhibits highly cemented zones that may result in potentially significant impacts related to the generation and use of oversize materials. Specifically, the presence of oversize materials in engineered fill can result in effects such as differential compaction and settlement, with related adverse effects to overlying pavement, utilities, or drainage improvements. These potential impacts would be evaluated as part of the detailed geotechnical investigation described in Section 4.5.4, with typical remedial measures including efforts such as: (1) restricting the placement of materials

between 12 inches and four feet in maximum dimension to areas at least 15 horizontal feet away from slope faces, five feet below finish grade, or three feet below the deepest utility, whichever is deeper; and (2) requiring site-specific evaluation by the project geotechnical engineer for use of oversize materials greater than four feet in maximum dimension.

Foundation/Footing/Pavement/Retaining Wall Design

Project-related foundations, footings, pavement, and/or retaining walls may be subject to significant impacts from potential effects associated with seismic loading, liquefaction, compressible/expansive soils, and/or surface/subsurface drainage as described above. The proposed design of project facilities would be evaluated as part of the detailed geotechnical investigation described in Section 4.5.4, with typical remedial measures including appropriate structure design/location, earthwork, and drainage considerations as noted above in this section.

4.5.4 Mitigation Measures

Implementation of the proposed project may potentially be subject to significant geotechnical impacts related to seismically-induced ground shaking and liquefaction/dynamic settlement, as well as soil erosion, compressible/expansive soils, shallow groundwater drainage, oversize materials and foundation/footing/pavement/retaining wall design. These (and other applicable issues) would be addressed in a detailed investigation of the project site and proposed development. This investigation, as outlined below, would be conducted pursuant to all applicable regulatory requirements of the City of Carlsbad and related standards such as the IBC and CBC.

GS-1 Prior to issuance of a project grading permit, a detailed geotechnical investigation report shall be submitted to the City Engineer for review and approval. This investigation shall address all geotechnical concerns identified in the Geotechnical Reconnaissance Report prepared for the proposed project by GEOCON (2010), as well as other applicable issues, and shall conform to all pertinent requirements of the City *Technical Guidelines for Geotechnical Reports* (City of Carlsbad 1993). Specifically, the detailed project geotechnical investigation shall review and update recommendations in the Geotechnical Reconnaissance Report for issues including seismically-induced ground shaking and liquefaction/dynamic settlement, as well as compressible/expansive soils, shallow groundwater drainage, oversize materials, and foundation/footing/pavement/retaining wall design. Project design, construction and maintenance shall implement and comply with all recommendations/requirements identified

in the approved detailed geotechnical investigation report, as well as any other applicable requirements identified by the City Engineer.

4.5.5 Level of Significance after Mitigation

Implementation of Mitigation Measure GS-1 would avoid or reduce all potentially significant geotechnical impacts to below a level of significance.

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